

## **THE RECOVERY OF RARE EARTH ELEMENTS FROM PHOSPHATE ROCK AND PHOSPHATE MINING WASTE PRODUCTS USING A NOVEL WATER-INSOLUBLE ADSORPTION POLYMER**

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The rare earth elements (REE) or rare earth metals are vital components in many modern electronics and are critical to the advances in several high technology fields, including green energy. While numerous procedures to extract and recover rare earth elements from phosphate waste products have been reported, none have seen widespread commercial acceptance due to various limitations, such as high cost and low efficiency, and the inability to economically extend the technology to large-scale operations. One way to achieve a commercially viable separation scheme is to employ a material that will economically and selectively bind various REEs in the presence of potential interfering ions, such as sodium, calcium, and silicon. In this study, the extraction and recovery of rare earth elements and phosphorus from phosphate rock and three phosphate fertilizer waste by-products, phosphogypsum, amine tailings, and waste clay, using 2.5% nitric acid and a novel water-insoluble adsorption polymer, poly (maleic anhydride-alt-1-octadecene) sodium salt, are examined. Overall extraction and recovery yields were between 80% for gadolinium and 8% for praseodymium from amine tailings, between 70% for terbium and 7% for praseodymium from phosphogypsum, between 56% for scandium and 15% for praseodymium from phosphate rock, and between 77% for samarium and 31% for praseodymium from waste clay. Average REE extraction and recovery yields were 50% to 60%. Poly (maleic anhydride-alt-1-octadecene) sodium salt effectively bound 100% of the rare earth elements extracted from the solids. Phosphorus was not chelated by the polymer and was isolated from the extract solution in yields of 16% to 34%. These results suggest that this process may be an efficient means of recovering rare earth elements and phosphorus from phosphate mining waste products.